

LIS009638284B2

# (12) United States Patent

#### Yoshida et al.

#### (54) WEAR-RESISTANT CHAIN PIN

(71) Applicant: **BorgWarner Inc.**, Auburn Hills, MI

(72) Inventors: Yukio Yoshida, Yabata (JP); Yasushi

Miyazaki, Yabata (JP)

(73) Assignee: BorgWarner Inc., Auburn Hills, MI

(US)

(\*) Notice: Subject to any disclaimer, the term of this

patent is extended or adjusted under 35

U.S.C. 154(b) by 0 days.

(21) Appl. No.: 14/772,104

(22) PCT Filed: Mar. 12, 2014

(86) PCT No.: **PCT/US2014/023837** 

§ 371 (c)(1),

(2) Date: Sep. 2, 2015

(87) PCT Pub. No.: WO2014/159475

PCT Pub. Date: Oct. 2, 2014

(65) **Prior Publication Data** 

US 2016/0003324 A1 Jan. 7, 2016

(30) Foreign Application Priority Data

Mar. 14, 2013 (JP) ...... 2013-051306

(51) **Int. Cl.** 

*F16G 13/04* (2006.01) *F16G 15/12* (2006.01)

(Continued)

(52) U.S. Cl.

CPC ...... F16G 15/12 (2013.01); C23C 8/72 (2013.01); C23C 12/02 (2013.01); F16G 13/00

(2013.01);

(Continued)

## (10) Patent No.: US 9,638,284 B2

(45) **Date of Patent:** 

May 2, 2017

#### (58) Field of Classification Search

CPC ............ F16G 13/00; F16G 13/02; F16G 13/04; F16G 13/18; F16G 15/12; C23C 8/72; C23C 148/227

(Continued)

#### (56) References Cited

#### U.S. PATENT DOCUMENTS

(Continued)

#### FOREIGN PATENT DOCUMENTS

JP 56006939 A 1/1981

#### OTHER PUBLICATIONS

International Search Report and Written Opinion dated Jun. 25, 2014; International Application No. PCT/US2014/023837; 9 pages.

Primary Examiner — David B Jones (74) Attorney, Agent, or Firm — BrooksGroup

#### (57) ABSTRACT

Problem. To provide a chain pin which makes it possible to improve wear resistance even in an environment in which degraded oil is used. Solution. A large number of pins are mixed/agitated together with a particle mixture including a penetrant comprising chromium (Cr) powder and tungsten carbide (WC) powder, and an iron chloride (FeCl<sub>3</sub>) catalyst, and WC particles penetrate the surface of the pins together with chromium carbide (CrC). As a result, a chromium carbide layer in which WC particles are diffused in a CrC layer (CrC—WC layer) is formed on the outermost surface part of the steel forming the parent material of the pins.

### 2 Claims, 6 Drawing Sheets



